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IMPLEMENTATION AND PERFORMANCE OF BEAM SMOOTHING ON 10 BEAMS OF THE NOVA LASER

D. M. Pennington, S.N. Dixit, T.L. Weiland, R. Ehrlich, J.E. Rothenberg
Laser Program, Lawrence Livermore National Laboratory,
PO Box 808, L-439, Livermore, CA 94550
Telephone: (510) 423-9234, Telefax: (510) 422-5537
e-mail: pennington1@llnl.gov

Optical smoothing of the laser irradiance on targets for inertial confinement fusion (ICF) has gained increasing importance for both direct and indirect drive plasma physics experiments. Recent simulations and experiments on Nova indicate that some level of smoothing may be required to suppress filamentation in plasmas on the National Ignition Facility (NIF), resulting in the addition of 1-D smoothing capability to the current baseline design. Control of stimulated Brillouin scattering (SBS) and filamentation is considered essential to the success of laser fusion because they effect the amount and location of laser energy delivered to the x-ray conversion region (hohlraum wall) for indirect drive and to the absorptive region for direct drive. Smoothing by spectral dispersion (SSD)[1], reduces these instabilities by reducing nonuniformities in the focal irradiance when averaged over a finite time interval.

We have installed SSD on Nova to produce beam smoothing on all 10 beam lines. The level of obtainable smoothing is a trade off between bandwidth and dispersion. The initial rate of smoothing is proportional to the bandwidth; however, to achieve efficient third harmonic conversion, the allowable bandwidth should not exceed the phase matching tolerance of the conversion crystals. In practice, this limits the bandwidth to ~ 3 Å at 1ω. For full smoothing to occur sufficient dispersion is required to produce an angular separation between frequency components equivalent to one half the diffraction limited spot size, ie., $1.22\lambda f/D$, where f is the focal length of the focus lens, λ is the wavelength, and D is the diameter of the beam at the lens. This condition is defined as critical dispersion. The achievable dispersion/bandwidth product is determined by the angular acceptance of the laser chain.

Our bandwidth source is a double-passed electro-optic modulator with a 3 GHz modulation frequency, capable of producing up to 3 Å of frequency modulated bandwidth. A single dispersion grating is located in a position common to all 10 beam lines early in the preamplifier chain. This location limits the 1ω bandwidth to 2.2 Å with critical dispersion. Several beam lines were modified to allow orientation of the dispersion on each arm relative to the hohlraum wall. After conversion to the third harmonic the beam passes through a kinoform phase plate (KPP) designed to produce an elongated spot at best focus. The KPPs produce a focal spot having an elliptical flat-top envelope with a superimposed speckle pattern. Over 93% of the energy is contained in the central 400 μm. Calculations indicate a 26 % rms. intensity variance will be reached after 330 ps for a single beam. We will present the results of experiments on Nova demonstrating the smoothing performance of this system.

1. S. Skupsky, R. W. Short, T. Kessler, R. S. Craxton, S. Letzring and J. M. Soures, J. Appl. Phys. **66**, 3456 (1989).

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